

MAR 17 1925

Volume II

January, 1925

Number I

Lubrication

A Technical Publication Devoted to
the Selection and Use of Lubricants

THIS ISSUE

Lubrication of
Electric Street Railways



PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS FOR ELECTRIC STREET RAILWAY EQUIPMENT

PARTS TO BE LUBRICATED	SUMMER	WINTER
Armature Bearings.....		
Axle Bearings.....	TEXACO Electric Car Oil, Summer	TEXACO Electric Car Oil, Winter
Car Journals.....		
Waste Saturation.....	TEXACO Electric Car Oil, Summer	TEXACO Electric Car Oil, Winter
Ball and Roller Bearings.....	TEXACO Marfak Compound No. 3	TEXACO Marfak Compound No. 3
Compressors:		
Car.....	TEXACO Electric Railway Compressor Oil, Summer	TEXACO Electric Railway Compressor Oil, Winter
Shop.....	TEXACO Electric Railway Compressor Oil, Summer	TEXACO Electric Railway Compressor Oil, Winter
Gears and Pinions.....	TEXACO Crater Compound No. 5	TEXACO Crater Compound No. 2
Miscellaneous:		
Truck Side Bearings.....		
Truck Center Plates.....		
Draw Bars.....		
Radial Bars.....	TEXACO Summer Black Oil	TEXACO Winter Black Oil
Guides.....		
Pedestal Plates.....		
Brake Rigging.....		
Door Engines:		
Slides.....	TEXACO Liquid Grease "D"	TEXACO Liquid Grease "D"
Controls.....	or TEXACO Star Grease OO	or TEXACO Star Grease OO
Air Brake Cylinders:		
Piston Leathers.....	TEXACO Liquid Grease "D"	TEXACO Liquid Grease "D"
	or TEXACO Star Grease OO	or TEXACO Star Grease OO
Controller and other Electric Contacts:		
Fingers.....	TEXACO Liquid Grease "D"	TEXACO Liquid Grease "D"
Trips.....	or TEXACO Star Grease OO	or TEXACO Star Grease OO
Drums.....		
Reverser Drums.....		
Motormen's Valves:		
Inspection or Overhaul.....	TEXACO Liquid Grease "D"	TEXACO Liquid Grease "D"
	or TEXACO Star Grease OO	or TEXACO Star Grease OO
Circuit Breaker Pins.....		
Switch Pins.....	TEXACO Electric Railway Compressor Oil, Winter	TEXACO Electric Railway Compressor Oil, Winter
Trolley Wheels:		
Hollow.....	TEXACO Liquid Grease "D"	TEXACO Liquid Grease "D"
	or TEXACO Star Grease OO	or TEXACO Star Grease OO
Solid.....	TEXACO Electric Railway Compressor Oil, Summer	TEXACO Electric Railway Compressor Oil, Winter
Trolley Bases:		
Plain Bearings.....	TEXACO Electric Railway Compressor Oil, Summer	TEXACO Electric Railway Compressor Oil, Winter
Ball Bearings.....	TEXACO Grease OO	TEXACO Grease OO
	or TEXACO Star Grease OO	or TEXACO Star Grease OO
Fans.....	TEXACO Nabob Oil	TEXACO Nabob Oil

Continued on inside back cover

E. Eng. Pub.
direct

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

Published Monthly by

The Texas Company, 17 Battery Place, New York City

Copyright 1925, by The Texas Company

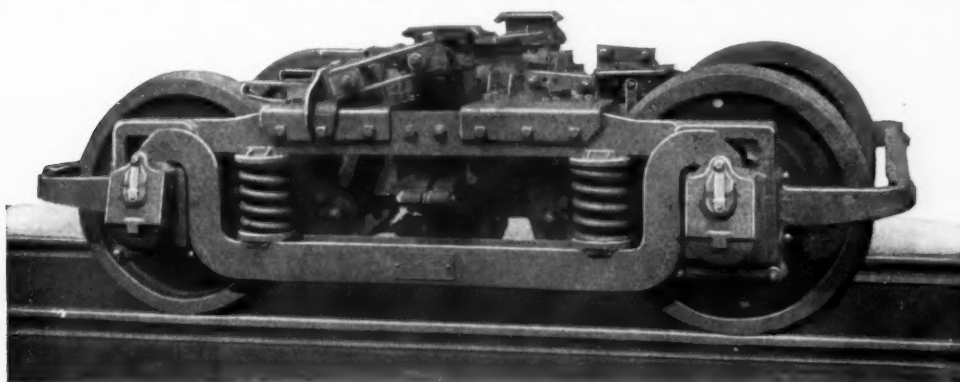
Vol. XI

January, 1925

No. 1

Change of Address: In reporting change of address kindly give both old and new addresses.

"While the contents of LUBRICATION are copyrighted, other publications will be granted permission to reprint on request, provided article is quoted exactly and credit given to THE TEXAS COMPANY."



Courtesy of J. G. Brill Company.

Fig. 1.—A Modern Truck for Electric Street Railway Cars.

Lubrication of Electric Street Railways

AN honest study of the giant railway and petroleum industries as they move in the service of civilization, produces a thrill similar to that experienced when contemplating any great masterpiece. We are all probably very familiar with the magnitude of the petroleum industry. Let us then picture some of the more intimate details of the other giant.

In 1923 street railways of the United States carried 16,000,000,000 passengers. This incomprehensible figure is cleverly brought within the grasp of our minds by the statement that if this army of people were mobilized and lined up four abreast they would form a column which would encircle the globe at the equator 242 times.*

To render this service nearly 105,000 cars

and 47,000 miles of track were required; not to mention the power houses involved, real estate, accompanying buildings and structures, and co-operative bus lines.

In 1924 the street railways spent \$262,000,000 for maintenance and the purchase of materials, supplies and equipment. During 1925 they expect to increase this figure by about 30%. We glory in such strength.

Another economic picture easily drawn from the railways is the importance of the use of correct lubricants and their application as related to profits. The cost of lubrication is relatively small—about a thousandth part of total operating cost or about two per cent of the maintenance cost. When a car is run off the road for a hot journal, the resultant cost through repairs and loss of revenue-miles is estimated at about twenty dollars. Should a motor bearing fail, the armature is usually

*Statistics from the Chicago Surface Lines as published in "Electric Railway Journal" for January 3, 1925.

F.E.R.

destroyed by rubbing on the pole pieces. The cost incurred for rewinding only, is between eighty and one hundred and twenty-five dollars. Think of these amounts if you will, in the equivalent number of fares or in the pints of oil. A buyer for a property who purchases an untried lubricant to save a dollar a car per year, therefore, takes a severe responsibility.

STORAGE, HANDLING, AND APPLYING LUBRICANTS

Most communities where street railways are found have an oil seller's warehouse within easy delivery radius. It is therefore unnecessary to carry large stocks in the railway's storehouse. The average building space allotted to oil storage is about 1.5 sq. feet per car, depending on the type of tankage, waste saturating, washing and reclaiming equipment. In any case, the oil room should be dry and fireproof, providing under the one roof also for the burning oils—signal oil, kerosene and gasoline and the lubricants. Waste saturating tanks should be fitted with heating devices. Economy, efficiency and prudence demand a clean oil house accessible to a minimum number of competent employees. Accurate records of receipts, stores and distribution should be kept. Proper lubrication begins with right oil house methods.*

LUBRICANTS REQUIRED

There are five chief street railway lubricants, namely, Car Oil, Compressor Oil, Gear Lubricant, Black Oil and a semi-fluid grease. The requirements for other lubricants vary with equipment and operating conditions. In considering them we must always keep in mind the severe conditions which oppose ideal lubrication. The equipment operates at high speeds over streets which are generally dusty and dirty and often wet. In extreme conditions the mechanism is immersed in water; but whenever water is present continuous wheel splash occurs. The lubricants have also to contend with the full range of atmospheric temperature changes, frictional and electrically generated heat. The latter of these is usually caused by overloading, although it can be produced by low voltage. The low voltage is generally due to poor track bonding, although often aided by contributory conditions of power house, substation or overhead.

CAR OIL

Car oil is used on the largest, most important bearings and in the largest quantities so that it probably deserves prime consideration. It is employed for the lubrication of journals, and armature and axle bearings, the latter forming part of the motor suspension which maintains

constant distance between the center lines of the armature and axle. The waste must be in contact at all times with the rotating member, otherwise lubrication will fail.

Research has proven that electric car oils should be straight mineral. The addition of animal or vegetable oils introduces the possibility of emulsification or "soaping" of the oil when water enters. This may cause the waste to glaze in contact with the shaft, destroying its capillarity or ability to feed as a wick.

Car oils are made from cylinder stocks which are usually refined from paraffin base crudes. Only two seasonal grades are necessary, as they blend perfectly. As one grade is added to the other already on the equipment, a gradual change to suit temperature conditions is brought about. The lighter winter grade is found to demand a viscosity at 210 deg. F. of approximately 55 seconds Saybolt and must have a pour test commensurate with encountered temperature. Electric winter car oils pour at about 0° F. The heavier summer car oil should have a viscosity of approximately 100 seconds Saybolt at 210 deg. F. The summer car oil is produced to have the same viscosity at average summer temperature as the winter car oil has at average winter temperature. Summer oil is used during the months where the temperature does not fall below about 40° F.

Variation in motor design, number of motors, loads carried, condition of equipment, patented oiling devices and the personal equation make

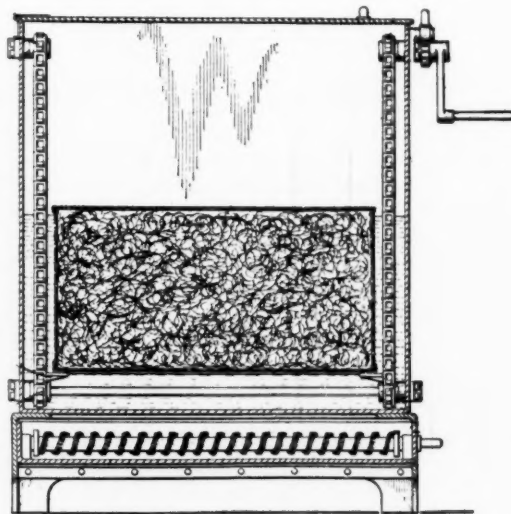


Fig. 2.—Electrically heated Waste Saturating Tank.

it impossible to estimate consumption, the rate varying from 800 to 3500 miles per gallon of oil.

*For further details on oil storage see "Lubrication" for January, 1924.

LUBRICATION

SELECTION AND SATURATION OF "WASTE."

Just a word about the quality of the waste. Resiliency and capillarity are the main requisites and any factor which decreases these, affects the lubrication adversely. The wastes now in use vary from 60% to 100% pure wool, cotton waste usually being added. The cotton waste has a larger oil storage capacity, lower capillarity, is not so resilient and will not lift

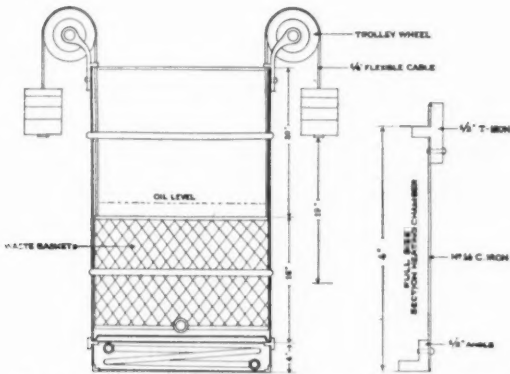


Fig. 3.—An inexpensive waste saturating tank easily made from metal "one time shipper" grease barrel.

the oil as high as wool waste. Felt has been used as a pad, but due to its tendency to glaze is inferior to wool waste on street railway work. To assure the greatest capillarity in wool waste, purchasing specifications should call for rejection if much cotton yarn is used or if it contains jute, sweepings, flying wire, leather, or other extraneous matter, or an excess of 10% by weight of moisture, or 15% by weight of oil or grease. Long strand wool waste, free from knots and kinks, gives better capillarity. Particular precaution should be taken against waste which has been "sized" in the process of preparation.

After good waste is secured it must be impregnated with the proper amount of oil. This process requires that the waste be submerged in oil at 70° for 48 hours and drained until about two pints only of oil remain per pound of waste. The draining usually takes about 24 hours. The proper oil content in the waste is usually judged to be correct if on pressing a ball of the waste in the hand a slight amount of oil works through the fingers. The process of saturation can be greatly accelerated by the application of heat. An electrically heated tank has been perfected having thermostatic control which maintains a temperature range from 118° to 122° F. and permits of completing the saturation of waste in four hours, two for soaking and two for draining. Beside the saving in time, the chief benefit lies in the *uniform* result obtained.

RECLAIMING "WASTE."

It is the usual practice on railways to reclaim waste. Methods vary. One of the most popular is to pick out the "dead" parts of the waste and place the remainder on a screen and circulate hot, clean car oil over it. The oil is cleaned by means of a heated compartment settling tank or by means of a centrifugal separator or by both. The precautions to be taken in doing this work are:

1. To see that the waste is well picked apart, so that the oil can flow to the innermost part of the mass.
2. To make sure that the water removed from the waste is positively extracted from the wash oil, thereby assuring a minimum of danger from waste glazing.
3. To check the pour test of the wash oil during the cold months; otherwise the success of the operation is jeopardized due to the raising of the pour test of winter car oil by the admixture of summer car oil found in reclaimed waste. Should the pour test of the wash oil rise unduly it becomes necessary to add a low pour test oil in sufficient quantities to reduce the pour test of the wash oil to proper limits.

Other reclaiming devices resemble clothes washing machines in principle and one utilizes a slatted tumbling box into which nails project which tear the waste apart while oil pours through the slats in a stream to wash out the dirt. In this last method care must be taken to prevent the tearing action from destroying the length of the strands. New waste is rec-



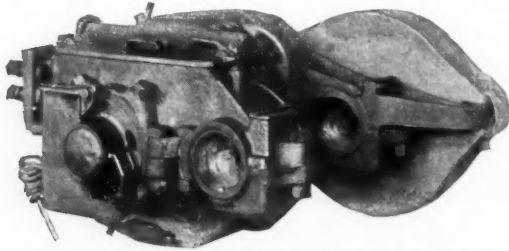
Courtesy of Electric Railway Journal.
Fig. 4.—A "Safety Car" Electric Motor.

ommended for *armature* bearings while the reclaimed waste should be used on journals and may be used on axles if there is an excess *after* the journals have been supplied.

PACKING THE "DOWN FEED" MOTOR.

The "down feed" motor was originally intended principally for grease lubrication. Experience has shown that longer life of bearings is to be obtained from oil than grease

or even the semi-fluid greases. On this type of motor the part of the housing which clamps the bearings was cast with a grease pocket or box above and below the bearing, some having only the box above. The bearing itself was made with a slot or "window" looking into



Courtesy of the Electric Railway Journal.

Fig. 5.—Electric Railway Car Motor of the Westinghouse Type, showing gear case.

these boxes. When only the top box was present the motor was intended for grease lubrication only, the frictional heat of the bearing melting the grease and bringing it down through the window in the bearing to the shaft. When the bottom box was included, the intention was that this box was to be filled with oil before assembling the bearing and fed to the shaft through a felt wiper, one end of which was against the shaft and the other end in the oil, the felt being held in place by a spring.

When the felts became worn the steel springs cut the shaft, and when copper springs were tried they quickly lost their resiliency. To add to the disadvantage of this arrangement was the tendency of the felt to glaze, also the fact that they could not be inspected without dismantling the motor.

Consequently the present practice is to close the bottom window and disregard the bottom box entirely by casting the bearing solid on the bottom which gives the advantage of increased bearing surface. Oil is fed through the top window which was designed for grease. Originally these top windows were about $\frac{3}{4} \times 3''$. In oil lubrication, these are increased as nearly as possible to the area of the horizontal cross section of the box so that better contact is afforded between the waste and the shaft and inspection of the shaft is facilitated. In packing such a box the saturated waste next to the shaft is first packed in tight, and oil is poured on top, then more waste and more oil, finishing with a piece at the top, above which no oil is added. This top piece is known as the "dust plug," and further serves auxiliary to the spring cover in keeping water and dirt out of the bearing. While as much waste as possible should be used in packing these boxes, precaution should be taken so that the cover will close tightly and all strands inside the box, as those hanging over the side will syphon the

oil from the box. It is necessary to re-oil these boxes more frequently than the modern type, some properties oiling as often as every 300 miles; and others as often as every other day. This period can be extended and better lubrication obtained by the application of the "Rico" type oiler which will be described later.

Some properties intentionally deter the flow of oil from the waste by means of felt or with grease. When using felt it is placed to completely fill the window and the waste is packed on top of it. The tendency of the felt to glaze makes it of questionable value. When using

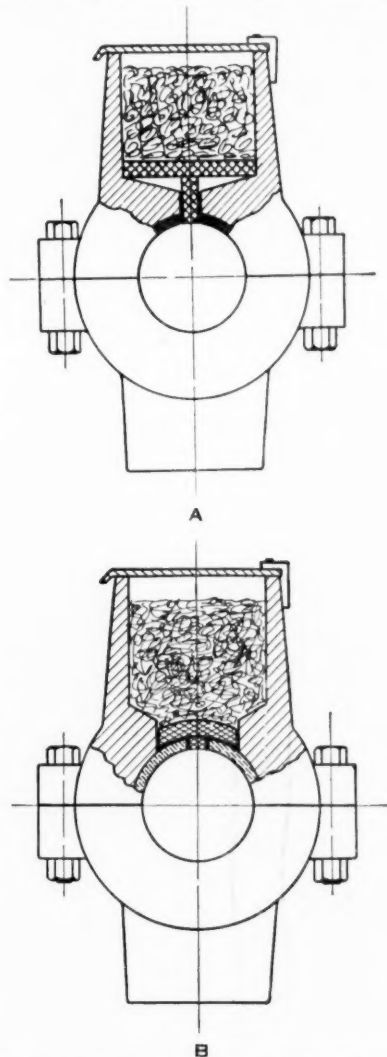


Fig. 6.—Cross section of a down feed motor bearing showing method of packing.

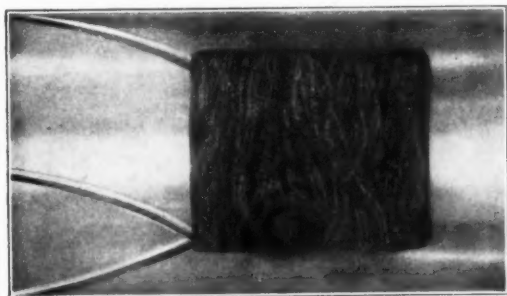
A—with unaltered housing.

B—with housing window enlarged.

grease the saturated waste is further impregnated with a grease and packed in that condition. A pool of oil is then poured on top

LUBRICATION

of the waste. The theory in this case being that should the bearing warm up, the grease will liquify sufficiently for the oil to come down to the bearing and when the bearing again cools, the grease solidifies and again deters the flow of the oil.



Courtesy of the Electric Railway Journal.
Fig. 7.—Westinghouse Bearing window.

There are several other schemes for lubricating these bearings:

1. Separating the grease pocket into two parts. One part is filled with oil which is taken over to the waste in the other part by means of the syphonic or capillary action of a wick connecting the two.
2. Another method is to use a grease cup similar to a "pin-oiler"—in this case the pin is a ball, opening and closing the hole in the bottom of the oiler as the shaft rotates.
3. The other oiling devices consist essentially of placing in the grease pocket a tin container filled with oil or saturated waste and having means for syphoning this oil into the bearing either down the sides of the box or a pipe through the center of the box.

In most of the above devices the introduction of dirt through the caps prevents their success.

PACKING THE "MODERN" MOTOR

But it is with the "modern" type motor that we must particularly deal because of its wide use. The principles of design of the housing are shown in Fig. 8 which you will note provides a waste well into which the bearing window looks. Adjacent to the waste well is an oil well. The two wells are connected by a hole at the bottom of the partition wall. Later designs have this division wall between the wells slotted throughout its length thus obviating the danger of closing the bottom aperture with dirt or other sediment. In the modern type of housing the capillarity of the waste is used to raise the oil from the bottom of the housing to the bearing. The

purpose is to give a more uniform oil feed and to exclude dirt. After being properly packed with well saturated waste, oil is added to the oil well to a level of $\frac{3}{4}$ " from the bearing window, and should never be allowed to feed to a point lower than 3" below the window or within a half inch of the bottom.

When more oil is added than is indicated as the high level, the feed is too fast to be economical and may even cause damage through short circuits by oil throwing on the commutator. To permit the level to drop below the minimum named, reduces the rate of feed below that required for good lubrication. In this connection it should be pointed out that the higher the lift required of the waste, the less oil it will raise.

Mr. C. Bethel of the Westinghouse Electric and Manufacturing Company has shown on a curve illustrating his article printed in the *Electric Railway Journal* of April 19, 1924, that on a 40 H.P. motor, about two and a half grams of oil are fed per hour with a half inch lift. This drops to one and a half grams



Courtesy of Electric Railway Journal.
Fig. 8.—Westinghouse Pinion End Housing correctly packed, with outer shell cut away, showing how the wick should be put in place.

when the lift is increased to one inch; and to about an eighth of a gram per hour with a three inch lift. It is assumed that the lift was the only variable factor. The last named rate is considered a minimum for good lubrication.

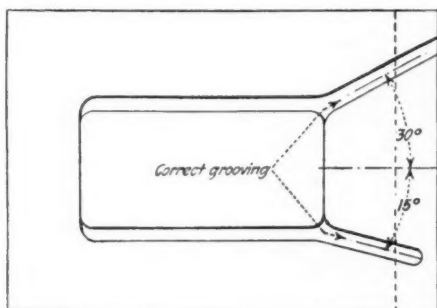
It should also be stated here that research has shown that the rate of feed is largely controlled by the viscosity of the oil, the higher the viscosity the lower the feed rate.

The importance of changing seasonal grades at the proper time is imperative, as the viscosity of an oil increases with a falling temperature.

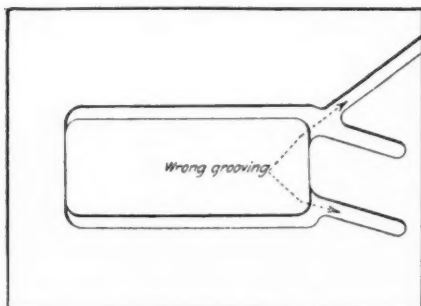
The correct way of packing the modern type motor consists in drawing the wool waste into a skein long enough to reach to the bottom

from touching dirty parts of the car under the floor.

All modern type motors should be gauged for oil level in the oil wells and only the amount of oil necessary to bring the level to the proper height should be added. Should gauging show that very little oil has been fed since the last inspection, there is very good reason to believe that the hole at the bottom between the two wells is plugged and it should be cleaned before oil is added. If the hole is kept open, all oil should be added through the oil well rather than to the top of the waste. Some dust is bound to get into the waste, and adding the oil on top, washes the dust down to the bearing. If evidence of water is found in the waste, the waste should be removed and the bearing packed with new waste as the water tends to emulsify with the impurities present, thus glazing the waste at the shaft, shutting off the oil feed. Motors subjected to high electrical heat should also be inspected frequently for glazed waste.



A



B

Courtesy of the Electric Railway Journal.

Fig. 9.—A—An arrangement of oil grooves with edges of windows chamfered that has proved satisfactory.

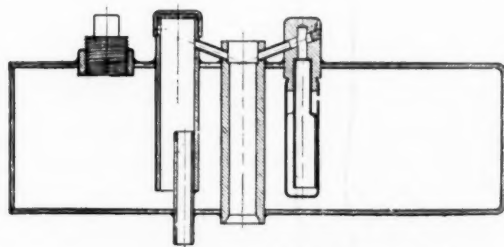
B—With the incorrect grooving shown it is not possible to drain the chamfer properly.

of the waste well and to reach over the bearing window. The skein should be long enough so that the oiler can hold it in place while packing the remainder of the waste. This skein acts as the wick and should be large enough to completely fill the window. After the wick skein is in place, waste is worked down behind it with a packing iron to wedge the wick up to and hold it in position against the armature shaft. A small piece of dry waste should be added on top to act as a dust plug. A properly packed waste well will hold more waste than one in which the waste is merely shoved in in balls. The additional waste improves the feed and insures the necessary flow when the proper levels are maintained. When oiling in the barn, it becomes necessary on some types of cars for the oiler to pack motors by feeling rather than sight, due to the fact that the bearing is located under and close to the car floor rather than under the floor traps. In such cases more than the usual care must be taken to prevent the waste

THE RICO TYPE OILER

Several years ago, the Railway Improvement Co. brought out an oiling device known as the Rico oiler which when properly applied overcame many defects of the previous types. As shown in Fig. 10 the oil is fed from the reservoir through an inverted U shaped wick. The capacity of the oil tank is 8 ounces and when sealed by the control tube cap, the filling plug and the oil in the reservoir at the bottom of the control tube, is air tight.

The wick feeds to waste in the grease box of the "down feed" motors or in the waste well of the "Modern" type motors. In both cases the waste being normally saturated and



Courtesy of Railway Improvement Company.

Fig. 10.—Rico Oiler for Armature Bearings, showing control tube at the left.

depends on the reservoir only for make up oil.

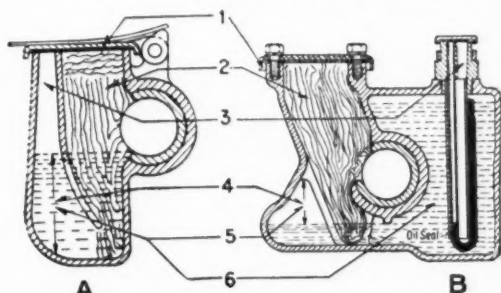
The rate of feed is controlled in two ways—first, by the type of wick which can be varied as to the number of strands used, or the feeding qualities of the wool employed; the second, by the expansion and contraction of the air in the top of the reservoir which regulates the height of oil in the control tube and

LUBRICATION

the consequent lift. With normal running heat of the motor, the oil rises to a certain height in the tube, but when the car is housed and the motor cools, the air contracts and withdraws the oil from the tube, thus shutting off the feed.

"OIL SEALED" HOUSING

Recently Westinghouse Electric and Manufacturing Company brought out a new housing called "Oil Sealed," as shown in Fig. 11. By



Courtesy of Westinghouse Electric & Manufacturing Co.

Fig. 11.—A—Modern Type Motor Housing; B—Improved Oil Sealed Motor Housing.

means of automatic feed such as that of a "chicken trough" the oil level in the waste well is kept constant. The new type housing provides a large oil reservoir and every precaution is taken to keep dirt out.

Our experience shows that for the same equipment and operating conditions, bearing wear is approximately inversely proportional to the amount of car oil properly used. Proper lubrication starts with the proper machining and grooving of the bearings. Fig. 9 shows one proper grooving which may be modified to meet local conditions. However, all edges must be chamfered, not only to prevent scraping of the oil film, but also to permit of oil distribution which is otherwise impossible. Excessive grooving increases unit pressure and results in rapid wear.

CAUSES OF LUBRICATION FAILURE

Assuming the use of high grade oil and proper waste saturation the principal causes of apparent lubricating failures may be traced to the following:

(a) Shifting of the bearings in the housing caused by shearing of dowels or keys, prevents the window in the bearing from registering with window in the waste well, thereby shutting off the oil feed.

(b) Distorted bearings, which are caused by forcing too tight a fit of the bearing in the housing. Guard against this by being sure that the motor turns over by hand after assembling.

(c) Loose or stretched housing bolts on the split type motors. This causes a bad fit

between the bearing and the housing and permits the oil to escape outside the bearing.

(d) Misuse of shims which gives the same effect as (c).

(e) Misalignment in reboring housings.

(f) Insufficient end play.

(g) Water which washes out the oil and causes waste glazing.

(h) Neglect which includes not only failure to apply oil at the necessary time, but also improper packing.

(i) Armature striking pole pieces due to worn bearings. This will cause you to ask, "How long should motor and axle bearings last?" The life of these bearings ranges from 50,000 to 250,000 miles. Long life of the bearings is dependent upon four main factors:

(1) They must be well and properly machined and fitted on all surfaces. (2) They must receive sufficient and continuous supply of satisfactory lubricant. (3) They must be packed and fitted to exclude dirt and water. (4) Temperature changes in the bearings due to electric heating should be reduced to a minimum. In general, motor bearings, are removed when the radial wear is $1/16"$ to $3/32"$ or when the air gap is reduced to $1/64"$.

Experience has shown that within economic limits wear is approximately inversely proportional to the quantity of oil applied. Dirt and water can be excluded from the bearings by proper maintenance of dust caps and waste box covers.

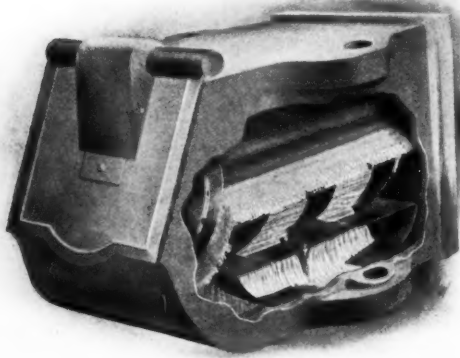
Axle bearing wear is not so harmful as armature bearing wear because the bad effects of excessive clearances are not so quickly noticed. However, excessive axle bearing clearances cause shocks and unnecessary strains in the motor frame, the axle caps and axle cap bolts, and change the center to center clearances between the axle and the motor shaft. This spreading of the gears results in excessive wear of the gears and pinions due to rubbing contact rather than rolling. Clearing should be limited to $1/8"$ but uneven wear of the two axle bearings should not be tolerated.

JOURNAL LUBRICATION

The same saturated wool waste as described for the lubrication of motor bearings is used to pack the journal boxes of the electric railway car. The practice on some properties is to add free oil to the waste in the journal boxes when periodic inspection indicates dryness. Other properties permit no free oil, applying only freshly saturated waste. For most efficient and economical practice no free oil should be applied, the application of freshly saturated waste insures proper oil distribution because of thoroughness of repacking. As pre-

viously explained under motors the dry waste is carefully preserved and used over again.

How often should journals be oiled or repacked? One metropolitan property packs journals only once a year, but it should be added that their track is as smooth as a billiard table, they have very few curves and



Courtesy of Armstrong Oiler Co.

Fig. 12.—Improved Armstrong Journal Oiler.

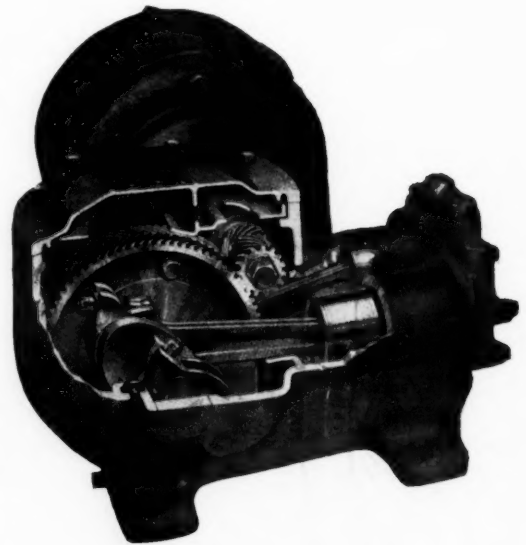
no special track work to speak of, and an average equipment speed which is low. On the other hand, another property practices punching up the waste to the axle every 1000 mile inspection and pulls all waste for packing and oiling every fifth inspection. In wet weather, on certain divisions, the journals are submerged in street water, necessitating the pulling of the packing after every storm. It is apparent that attention must vary with local conditions.

Journal boxes should be packed by entering a rope of saturated waste reaching around the bottom half of the journal and pushing it tightly against the back of the box to insure lubrication of the fillet and exclusion of foreign matter through the back of the box. The rest of the box is then filled with waste in as large pieces as possible—one piece if the design of the box permits. If one piece is used, it should be fed in gradually rather than in a ball, so as to prevent jamming that would allow voids. The waste should not be packed above the center line of the journal. Some workmen test for this by passing the packing iron between the top of the waste and the brass. Keeping the waste packed below the center line of the journal prevents the waste from dragging into the bearing.

On properties where track conditions cause the waste to work toward the front of the box, it has been found advantageous to twist the waste applied under the axle button. Under such conditions, too, a box using a thrust plate between the box and the brass helps in

keeping the waste in position since the plate takes a large part of the lateral sliding motion. In applying new brasses and check plates, it is good practice to smear the rubbing parts with oil before inserting them. *The necessity of keeping dustguards and journal box covers in prime condition to exclude dirt and water cannot be too strongly emphasized.*

Relative to fit, it is self evident that tapered journals should not be tolerated more than absolutely necessary as they reduce the bearing areas and increase bearing pressures. When it has been necessary to fit a brass to a badly tapered axle, some Master Mechanics have drilled anchor holes in the face of the brass and have run in half and half solder or a similar metal which would seat readily in service. When practiced, the anchor holes should be drilled well away from the center of the brass and the drill limited to 3/8". The practice of carrying in stock brasses of different diameters causes confusion. But experience has shown that where the *proper brass* is fitted to the *proper journal* the resultant longer life has compensated for the care required in keeping the brasses separate. Long life cannot be expected from brasses which bear only on a line at the top center of the journal or on two lines at the edge.



Courtesy of the General Electric Company.

Fig. 13.—Section view showing compressor end of a typical Air Compressor.

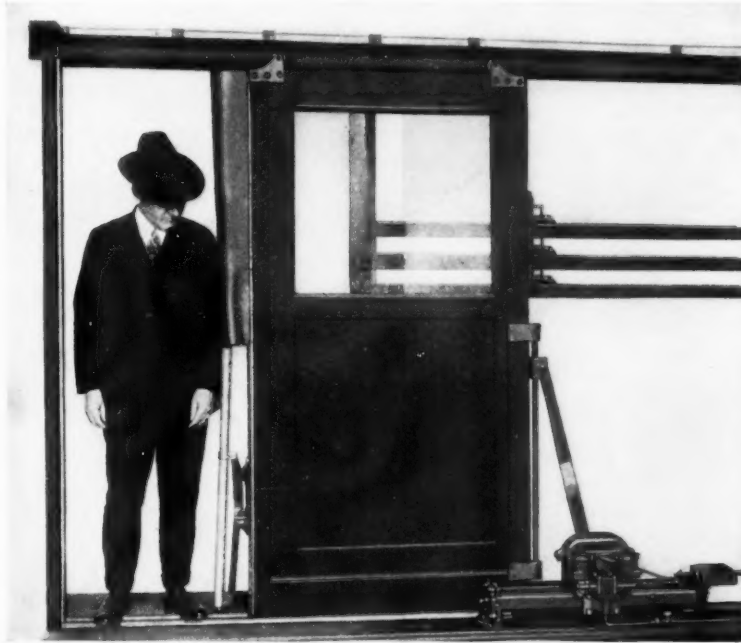
A volume could be written about the lining metals but such a discussion is not within the scope of this article. It must suffice to point out that the metal should be of such composition that bearing pressures and shocks

LUBRICATION

to which the brasses are subjected should be fully considered. It is common practice to use virgin metal on armature bearings and when melted out after use there, to employ it in journal brasses. Ordinarily this practice leads to a metal of unknown composition and

two seasonal grades to suit atmospheric conditions, the equipment being subjected to the full temperature range. The service to a large degree resembles the requirements of an internal combustion engine in that its function is not only to lubricate the piston on its path

up and down the cylinder, but also to seal against loss of the cylinder gases past the piston rings. It must be a non-gumming low pour test, full bodied lubricant. Gumming of the valves causes delayed action or poor sealing of the valves with consequent difficulties. The oil should flow at the lowest temperature encountered to minimize the motor load and to insure flow to all moving parts. The proper viscosity required for correct functioning has been found to be about 300 seconds Saybolt at 100 deg. F. for winter grades, and 500 seconds Saybolt for the summer grade. The oil is applied by pouring through a filling plug which is located at the heights of the oil level. The gear drive is lubricated by dipping into oil bath, or by the circulating oil in the crankcase.



Courtesy of National Pneumatic Company.

Fig. 14.—Sliding door with electric tripping device. Passenger obstructing door after which door reverses and then automatically starts to close again when obstruction is removed.

dependability. Check analyses of the melting pot contents should be made.

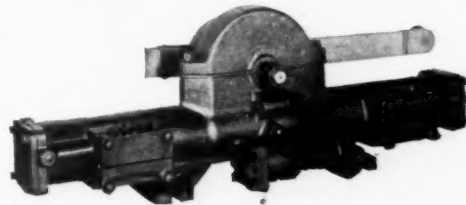
A word should be said about patented journal oiling devices. Some time ago an oiler was brought out which consisted of a pad held in place against the journal by a spring, woolen threads hanging from the pad into free oil in the bottom of the box. Encountered difficulties prevented the wide adoption of the oiler but it has recently reappeared with improvements. This is similar to European practice. The regular grades of Car oil serve this oiler satisfactorily.

For application of free oil to journals, an oiling can has been developed having an adjustable push handle, each stroke of which delivers a measured quantity of oil through a perforated nozzle which distributes the lubricant along the entire length of the journal.

COMPRESSOR OIL

There are two types of compressor lubrication systems, splash and ring oiled. As with Car oil the compressor oils are furnished in

Ordinary operating precautions to be followed include: (1) keeping the outside of the compressor clean so as to aid cooling; (2) keeping suction air strainers clean to prevent entrance of dirt into the oil and to insure an unrestricted air suction flow. A plugged strainer



Courtesy of The Consolidated Car Heating Co.

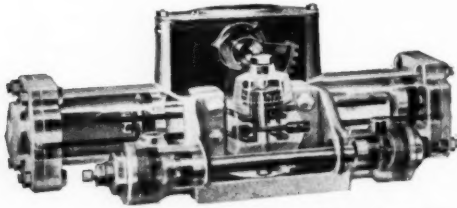
Fig. 15.—A Modern Door Engine.

has been experimentally proved to be capable of increasing motor speeds as much as 50% above normal, causing the armature to throw its coil and to throw oil through the breather holes; (3) keeping all oil passages clear to insure proper oil circulation. (4) renewal of

the oil at periods demanded by particular conditions.

GEAR LUBRICANTS

Gear lubrication is important to the street railway rider in that nothing can be quite so disagreeable on a continuous ride as the noise resulting from poorly lubricated gears. The railway operator finds it greatly to his interest to keep gear noise (i. e. wear) to a minimum,



Courtesy of The National Pneumatic Company.
Fig. 16.—Phantom view of a Door Engine.

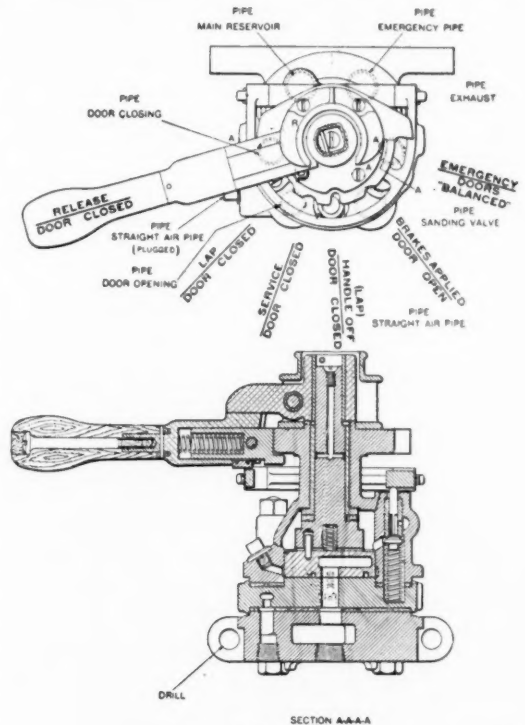
thereby preserving his costly gears. Whether of the spur or helical type the gears mounted on the axle, meshed with the pinion on the driving motor armature shaft, must be coated with a lubricant which will prevent metallic clash and grind by preventing wear. Experience has favored a straight run water resisting and adhesive lubricant of 2000 seconds viscosity Saybolt at 210 deg. F. for winter service; and 5000 seconds Saybolt at 210 deg. F. for summer use. The gear lubricant is usually applied cold by stringing out about a half pound and feeding it into the mesh of the gears where it spreads over the entire tooth surface. Frequent small applications result in more efficient lubrication than large applications at longer intervals. Applications are made at car inspection periods. This heavy non-fluid gear oil will absorb and envelop a certain amount of dirt, protecting the gears from the abrasive action of the dirt. The dirt is thereby lubricated and prevented from scratching or cutting the gears. Less viscous gear lubricants in an oil bath have been tried unsuccessfully. Also soft greases have been tried with the drawback that when they do not remain semi-fluid at low temperatures the grease channels and the gears run dry. The location of soft grease cannot be controlled and it leaks through gear case openings, possibly working into motor bearings where it glazes the waste or drips to the street. The necessity for tight gear cases to exclude dirt and water need barely be mentioned.

SEMI-FLUID GREASE

The semi-fluid grease must be adaptable to universal application, if the number of lubricants used is to be a minimum. It is used on controller fingers and other electric contacts.

For this service, the lubricant is rubbed on lightly and the equipment operated throughout its normal cycle, the excess lubricant being wiped off the edge with a lintless cloth. The requirements of the grease are: (1) that it shall stay where put for extended periods, (2) it must not carbonize or gum, (3) it should not be affected greatly by temperature changes.

Probably the largest volume demand for the semi-fluid grease is in the lubrication of door engines. On this equipment the manufacturer has co-operated with the lubricating engineers and have found a suitable lubricant which is light enough to flow to all parts requiring lubrication, including the valves and still not so "soupy" as to admit of dripping from the engine, such a condition being apt to ruin the gown of milady passenger or the topper of her knight. The engines are located in various positions—on the floor, back of partitions, over the door, in fact wherever the car design will permit. The engine is generally subject to temperature change and as it is initi-



Courtesy of The Westinghouse Airbrake Company.
Fig. 17.—A motorman's valve.

ally installed for the safety of the passengers and to facilitate handling of passengers, its very use demands that its action shall not be slowed down. About a pound of the lubricant is applied between the ends of the double piston

LUBRICATION

at the time of overhaul of the equipment, possibly once a year. During that year it must circulate with the air and motion of the piston to lubricate all parts regardless of temperature conditions and must retain a suitable con-

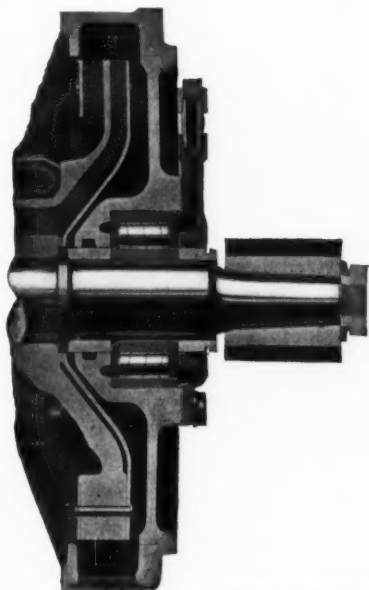


Fig 18.—A Hyatt Armature Roller Bearing.
Courtesy of Electric Traction.

sistency. It must, too, protect the piston leathers or cups from hardening or other deleterious conditions. These are exacting conditions, but still the problem has been successfully solved.

The same grease is used for parts of the air brake equipment—the motorman's valve and the air brake cylinders, foot valves and circuit breaker cylinders. These parts are taken down at time of overhaul, at which times the valve seats should be coated with the semi-fluid grease and an amount proportional to the dimensions be applied in the cylinders as described for the door engine cylinders. For the valves, the grease must be of a nature adhesive enough to resist the corrosive action of the air so that it continues to aid in the tightness of fit of the valve seats. It must not gum and must undergo a minimum of change through the temperature range to which the equipment is subjected. In the cylinders it must retain a consistency which will insure its spreading and also non-leaking qualities and must preserve the pliability of the leathers or cups without attacking them chemically.

A discussion of ball and roller bearings for motors and journals has not yet been entered into for while their lubrication is an important matter the application of the equipment in

the United States has been quite limited. Abroad they are in good standing. The difference in conditions has been argued recently in street railway reports and publications and the manufacturers in this country have recently brought out more forcefully the importance of the ball and roller types.* For the roller bearing journals which are fitted for oil lubrication, the regular grades of car oil are suitable. On the ball bearing motor bearings which are usually provided for grease lubrication, American railways use neutral soft cup greases, a higher melting point grease being used in the warmer temperature months or climate. The only objection encountered in the use of these greases exists where the bearing depends upon felt to retain the lubricant in the bearing. Where these are not kept in the condition necessary to retain the grease, grease throwing results. The grease maker has met this condition by producing a cylinder stock grease of remarkable lubricating quality which has overcome the difficulty and has permitted of operating ball bearing motors without further application of lubricant for upward of four months.

MISCELLANEOUS BEARINGS

In the preceding pages we have discussed those bearings and moving parts which are of outstanding importance and on which it happens that the bulk of the annual requirements of lubricants is consumed. In addition there are a number of others which, as a rule, offer no particular problems in lubrication and which are satisfactorily lubricated with one or the other of the five grades of lubricants already mentioned as being essential. Every effort has been made to keep to a minimum the number of different grades of lubricants necessary to be stocked in the oil house. Among the more important of the miscellaneous points requiring lubrication and not mentioned above are:

- 1—Brake Rigging,
- 2—Center Plates,
- 3—Trolley Wheels,
- 4—Trolley Bases.

BRAKE RIGGING

The lubrication of the Brake Rigging offers no severe problems. The satisfactory practice is to swab the moving parts (chains, brake rods, etc.) with a Black Oil or Slop Oil. This, of course, should be done frequently enough to insure positive operation, but the applications vary very much with dust, mud and water conditions.

*Lubrication of ball and roller bearings will be discussed in a future issue of LUBRICATION.

CENTER PLATES

Lubrication practice varies and since present designs permit severe exposure to water, mud, dust and dirt, no method can be called satisfactory, but probably the treatment described under Brake Rigging is as good as any for the lubrication of Center Plates.

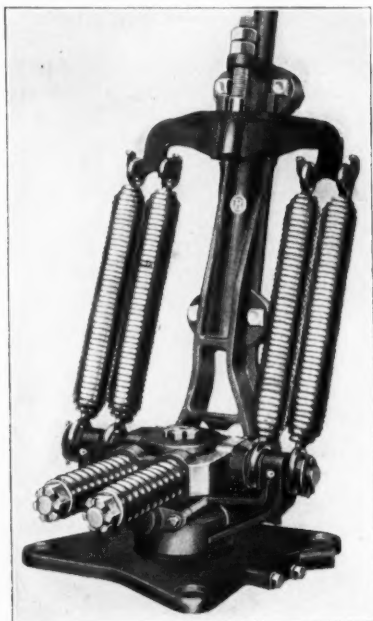


Fig. 19.—A Modern Ball Bearing Trolley Base.
Courtesy of Ohio Brass Company.

TROLLEY WHEELS

The slide under the Trolley Fork should be frequently lubricated with the compressor oil as stocked for the air compressors; the same lubricant should be used on the Hub if solid. If the Hub is hollow, a soft grease should be applied.

TROLLEY BASES

The best practice in the lubrication of the Trolley Bases is the frequent use of the compressor oil of the same grade as stocked for the air compressors and as described above under that heading.

POWER PLANT

Lubrication of the Power Plant is a subject in itself and has been thoroughly covered in a past issue of this publication.*

*See LUBRICATION for November, 1923.

CONCLUSION

Up to this point the engineering features of the subject have been discussed, but we must not close without a mention of the effect of the methods of purchasing on lubricating costs. A form of lubricating contract formerly prevalent was known as "the guaranteed mileage contract." Roughly outlined, the plan was to have the lubricant seller guarantee to the railway buyer that the cost of lubrication, per thousand car miles, would not exceed a price named. The oils were paid for by the gallon at time of delivery, the price per gallon generally was high, and the final settlement was made at the expiration of the contract.

Such a contract was unfair to the railways because it usually forced them to take from their treasury money in excess of that due the seller. Contracts made in this way produced waste of oil by placing Railways on a flat rate basis, and by this example fostering waste of other materials. When the seller insisted upon the utmost economy where the guess had been too low—and a loss was indicated, many a bearing was starved for oil resulting in excessive wear or badly damaged equipment. This method was unfair both to the buyer and seller due to impossibility of forecasting the raw material and labor costs a year in advance.

Fortunately for all, the guaranteed mileage contract has been consigned to the economic graveyard and is now almost extinct, practically all buying being done on the straight gallonage basis. The old form served its purpose to all in its lesson of futility.

Due to the limits of space available in this publication, it is impossible to treat this subject in more than a sketchy manner. Enough has been said, however, to demonstrate that careful attention paid to the lubrication of Electric Street Railway Equipment will repay large dividends in lower maintenance and operating costs.

This is a day of specialization and the Railway Manager is fortunate in having at his disposal the trained technical lubrication engineering staff maintained by those larger oil companies that specialize in this class of lubrication. It is the business of these lubrication engineers to help solve these problems with a view to minimum maintenance costs and their aim is to sell LUBRICATION—not just oil.